CASE STUDIES - AGROFORESTRY

Introduction

Cervinka et al. (2001) reported that 700,000 trees have been planted in the San Joaquin Valley (SJV) between 1986 and 1997. In 1986 these sites were classified as "agroforestry demonstration". The proposed use was to utilize the agricultural drainage water to irrigate the trees. *Eucalyptus camaldulensis* was selected as the main species because it was anticipated that it would provide an economic wood product and the tree was reputed to have evapotranspiration rates greater than pan evaporation. The hypothesis was that the trees would utilize vast quantities of the drainage water, concentrating the salt and partially eliminating the need for drainage water disposal in the SJV. One person has verbally reported that 500,000 trees died as the experimenters learned to grow trees with drainage water. Although this number cannot be quantitatively verified a large number of trees have died from various causes including frost damage.

The following summarizes the available information on fifty-one sites that were utilized for tree planting during the study period. Four paper storage boxes were obtained from the California Department of Water Resources. The information was sorted into one box representing agroforestry in the San Joaquin Valley. Data varies considerably from one site to the next; some sites having only a name and the number of acres planted to trees. Others have additional data on species of trees and number of trees planted. Some also have soil sampling data, groundwater data, irrigation water quantities and quality taken at the beginning of the project. A few have some data from three years or more. In the beginning there seems to have been more interest in quantification of the sites than occurred in later years. In general there is a lack of consistency in the data collection and a lack of organization once the data had been collected. Irrigation water quality and quantity is one of the main areas lacking in data. At a few sites leaf sample data was also collected, but no clear relationship can be reconstructed between these data and the exact location at the site from which samples were taken.

Part of the reason for large number of tree deaths was the severe freeze in the winter of 1990-91. The clones of *Eucalyptus camaldulensis* and *Casuarina* had various abilities to tolerate the freeze (most having no freeze tolerance). After 1990, clones were selected from the surviving trees that were more tolerant of both freezing temperatures and salinity. Many of the sites were then replanted, but if there is data on this it has been unavailable to this project. There was also a change in emphasis on trees from utilizing drainage water for irrigation to interception of underground drainage water and serving as "vertical pumps".

In most instances the following data are simply presented as found. In a few cases the author has editorialized and noted the lack of data and the missed opportunities for information that may have enhanced further work of this type. Cervinka et al. (2001)

conclude that prior to planting soil sampling should be done and that soil salinity, EC_e, should not exceed 15 dS/m, SAR should be less than 40, and boron should be less than 30 ppm. They also state, drainage water (if used for irrigation) and shallow groundwater should have EC less than 12 dS/m, SAR less than 30, and boron content less than 10 ppm. The descriptions, which follow, may indicate the basis of these conclusions. The conclusions, however, do not reflect the influence irrigation with saline water will have on soil physical conditions.

The following three tables summarize the sites based upon information available. The first table lists those agroforestry plantations known to have been irrigated with saline drainage water. Later in the report, Table 2 lists those sites that had "test blocks" for the propagation of salt tolerant trees. Lastly,Table 3 lists sites where the trees were planted for the purpose of intercepting groundwater flows. There is some duplication, such as TLDD being represented on both the saline drainage water list and the test block list. It should also be noted that Mendota and Red Rock Ranch are not portions of this case study report, but are separate sections. It should also be noted that there were sites listed as case studies which were simply planted on saline soils, but where no evidence was provided as to irrigation with saline water. Tables within the individual agroforestry sites have not been numbered separately.

Table 1: Agroforestry sites known to have been irrigated with saline drainage water.

Site Name	Size Acres	Total Trees	Saline Irrig.	EC Ds/m	Euc.	Cas.	Soil	GW	Ht. m	DBH cm	Leaf	Notes
Mendota	14.7	10,475	Yes	9.4	Yes	Yes	Yes	Yes			Yes	
Dink Allen	5.0	7,000	Yes	7.0	Yes	Yes	Yes	Yes			Yes	
Peck Ranch	8.2	8,630	Yes		Yes	Yes	Yes	Yes	165	2.5	Yes	Gone
Thomsen	15.0	17,875	Yes	5.0	Yes	Yes	Yes	Yes	241	2.94	Yes	Gone
Rodriques	31.2	19,000	Yes	12.4	Yes	No	Yes					
Stratford P.U.	7.0	11,200	Yes	12.4	Yes	No	Yes		0			Dead 87
Tulare Lake DD *	35.0	29,000	Yes	8.0	Yes	Yes	Yes	Yes	161			Test blk
Westlake Farms	38.0		Yes	17.0	Yes		Yes	Yes			Yes	Test blk
Verdigal	8.0	11,800	Yes	7.0	Yes	Yes	Yes	Yes	264		Yes	
Red Rock	13.0		Yes	10.0	Yes		Yes	Yes				Dead 97
Totals	175.1	114,980										

* at TLDD it has been reported that 120 acres were planted to trees. This may have been planned at one time, but realistically only about 35 acres were planted.

Dink Allen Ranch (Fresno County)

This is a five-acre site near Ashlan and Lyon Avenues northwest of Mendota, California. 6500 *Eucalyptus camaldulensis* and 500 *Casuarina* (other) were planted July 9, 1986 in a plot 100 feet wide by ½ mile long. That first year the trees were irrigated with water from a sump that at least once tested at 7.0 dS/m. The quantities of irrigation water were not metered but were estimated at 1.5 acre-ft per irrigation. There is apparently no report as to the status of the trees during the first growing season.

These are comments the following year: "... trees looked good in March 87; doing well June 1987." Morris Martin reported July 1, 1987, "Viewed 5 acre planting at Dink Allen. This planting is doing very well with an average height of about five feet tall – well cared for – survival about 95%. *Casuarina* doing well – good being in the outer row windward side as it serves as a windbreak for other trees. *Casuarina* grows firmer and straighter under windy conditions. Weed control is good. They have used Fusalade and Goal as well as Roundup." The growth (height and diameter breast high) was also measured at this time. Tree heights ranged from 52-206 cm (133 avg.) and DBH from 0 – 6.5 cm (1.06 avg.).

The reports on the irrigation water are also better in 1987/88.

Date	EC dS/m	Quantity
06 Sept. 87	8.87	Unmetered irrigation
22 Oct. 87	2.82 (tailwater mix)	
02 Mar. 88	9.41	Unmetered irrigation
08 June 88	10.93	Partial irrigation – south end
15 June 88	11.81	Ditto
28 June 88	10.32	Unmetered irrigation

The brief notes on the condition of the trees continue: "Jan. 88 frost damage, Mar. 88 regrowth, May 88 vigorous regrowth."

The trees in this area were a part of the wildlife study conducted by the biology department at CSU-Fresno and two monitoring wells were checked periodically from Oct. 1986 through 1992. Depth to water ranges from 3 to 6.5 ft and the EC from 6 to 14 dS/m basically dependent upon the time of year. This data is available, but is of little value standing alone.

Some notes from the wildlife study. Wheat had been grown in the area in 1984 and cotton in 1985. (Before the planting of trees.) By the end of the wild life study in May 1989 the trees were nearly 7 meters in height. There was a mature row of tamarisk trees (50 meters wide) located near the northeast corner of the site, across a farm road that contributed to the wildlife diversity at the site.

From other information it is known that after the December 1990 freeze some of the frost tolerant trees at this site were selected for further use in SJV drainage water

reuse experimentation. Clones 4543, 4544 and 4545 were selected from this site – perhaps other clones as well. In the spring of 1990 the trees were flooded. Vashek Cervinka (2001, personal communication) reports that the site is in current use as an agroforestry site.

On July 27 1992, Engineering Research Institute Labs reported the following from plant tissue taken from the Allen Plot.

Analysis	Units	Results of 12/91 sample	Results of 4/92 sample
Boron	mg/kg	320	240
Calcium	mg/kg	2480	3330
Magnesium	mg/kg	2140	2470
Sodium	mg/kg	160	400
Potassium	mg/kg	14300	15200
Chloride	mg/kg	87	64
Nitrogen, nitrate	mg/kg	820	5
Nitrogen, total	mg/kg	6600	7620
Phosphorus, PO_4	mg/kg	567	754
Arsenic	mg/kg	0.8	0.2
Selenium	mg/kg	0.4	0.4
Molybdenum	mg/kg	Not detected	Not detected

There may be other samples from previous years, but there is little value to these isolated leaf sample results, other than perhaps to indicate the boron concentration in the leaf tissue over time. Leaf sample reports are not reproduced for any other site in this report. Some additional data is available in the boron section of the final report for this project.

This also is a case of missed opportunity. Clearly the trees were irrigated with some drainage water. The trees appear to have done well – at least in the initial phases of the demonstration planting. In this case, it appears that no before and after soil information is available. Data was not kept on the quantities of irrigation water used. Unanswered questions are: Is boron accumulating in the soil as well as in the plant tissue. What were the levels of boron in the irrigation water? What are the levels of boron in the soil? Is there any follow-up information on the growth and health of the trees. They (at least some) were 7 meters tall in 1989. Someone collected leaf tissue in 1991 and 1992, were any notes taken on the trees themselves?

Sumner Peck Site (Fresno County)

Information available states that trees were planted at this site beginning in July 1985. 7700 *Eucalyptus camaldulensis* and 855 *Casuarina* (other) were planted the first year and 75 *Casuarina cunninghamiana* were added to the plot totaling 8.2 acres in 1986. The workplan for this site states that cotton was growing in 1984 and that the site is located next to evaporation ponds in operation at the time. The stated purpose is "Production of tree crops on saline soils to utilize subsurface drainage water."

Soil samples taken in January 1986 indicate that the soils were moderately saline with the surface 12 inches having EC = 6.2-6.7 dS/m and SAR 4.5. The salinity tended to decrease to 36 inches, having EC = 3.7 dS/m in the third foot. Details of fourteen soil samples taken in May 1986 are available, but a map locating the samples was not found. Most of these samples are similar to the information above, but two samples did have higher EC values in the 12-24 and 24-48 depth range 6.37-9.74 and 11.94-12.57 dS/m respectively. Water samples from shallow wells were collected starting in the fall of 1985. The water table was approximately two feet below the surface and EC of the water samples ranged from 5.8 to 6.4 dS/m. The water table began dropping in December and was below six feet by June 1987 and below nine feet during August and September that year.

A statement is found that the trees were irrigated with ½ water table or low quality irrigation water. Other comments: "Cotton defoliant damage again in 1987? Loss of smaller individual trees can be traced to rodent damage and trees completely water from the evaporation pond." For 1987 a note indicates 2 acre-ft for the past year as the amount. A note dated Sept. 29, 87 states "irrigation seemed heavy". Notes as to the condition of the trees are as follows: " 3/87 lots of weed competition. Approx. stand density 50%. "Cotton defoliant damage in the fall of 1985 and in 1986." 10/87 plot work underway in dry evaporation pond. Fall 87 many eucalyptus yellowish may be high covered by weeds. 1/88 frost damage present. 3/88 regrowth of frost damaged tips."

February 5, 1987 trees were measured for height and DBH. Casuarina avg. height 7'8" and 1.0" DBH; eucalyptus avg. 5'6", DBH 0.9". No further data or statements on the trees.

There is extensive data on the soil, water table depth and leaf analysis. Vashek Cervinka reports that this site has been abandoned as an agroforestry site. The trees were removed at some point after the 1990 freeze.

Water sample shown below (Unknown as to irrigation water or water sample from monitoring well):

Date	pH	EC	SAR	*	CO3-	No3-N	Cl	Na	Ca +	B	Se	Na
		dS/m	adj		meq/l	mg/l	meq/l	meq/l	meq/l	mg/l	PPB	mg/L
5/5/88	7.5	7.6	11.5		10.1	11	18	55	45.7	3.1	118	2900

* total carbonate ion in solution (dissolved CO_2 , HCO_s^-, CO_3^{2-})

Thomsen Site (Fresno County)

In late May to early June 1986, 8700 Lake Albacutya *Eucalyptus camaldulensis* and 475 *Casuarina cunninghamiana* were planted at this site on seven acres of land. In 1987, an additional 8700 Lake Albacutya *Eucalyptus camaldulensis* were planted bringing the total acreage to 15. Notes from this site are: Mar. 87 "trees look very good, staked trees." June 87 – "Trees planted 6/15 in six rows, ½ mile long 6.5'-5.5', 3 acres next to sump one mile S and ½ mile E of first planting." Sept. 87 "Original planting pruned prior to irrigation Beds prepared for additional planting." Oct. 87- "Planted 3 acres space 6.5' x 5' in hi water table area, has been tiled to SL drain. "Next to sump." Many seedlings showing necrosis and defoliation." Fall 87 "Heat and water stress in summer caused some leaves to turn brown and the tops of some trees to bend. Tops were removed in effort to encourage vertical growth, but did not work and are not recommended. Trees facing west are not as tall and robust as trees farther in." Jan 88- "Frost damage present." Mar. 88 "Regrowth of frost damaged tips." June 88 "Staked young trees."

Good quality Westlands water was used to irrigate the trees during the first year. Total amount 1.5 feet. Other irrigation dates are 15 May 87, 02 Sept. 87, 19 Sept. 87, 11 Feb. 88 and 30 June 88. The 02 Sept. 87 irrigation was from a sump with EC 4.93 dS/m. All other irrigation was apparently with tailwater.

Depth to water table and EC readings are available starting 29 Oct. 1986 and ending in 1992. EC ranges from 6.5 to 9.5 dS/m, depths from 3.5 to 7 feet below the surface. More detailed water analyses are available for samples from these observation wells for 04 May 87, 22 Oct. 87 and 05 May 88. EC for these samples range from 7.2-7.7 dS/m and SAR adj. from 27 to 36. Additional samples taken 12/16/91 and 4/9/92 indicate lower SAR 13-22, but higher EC 16 and 13.2 dS/m.

Water management information and a wildlife study was performed by CSU-Fresno at this site. The wildlife study stated that the trees were 10-12 meters in height by 1989. This study also reports that tomatoes were grown on the site 2 years prior to the planting of trees. There was a sump pond on the east side that ran 2/3 the length of the tree plot. Vashek Cervinka reports that this site was closed in 1992 after the 1990 freeze.

There is extensive additional data for this site. It is mainly data on monitoring wells, which were taken by CIT staff (depth and EC). It is believed they were attempting to determine the effect of irrigation with drainage water upon the water table, but without excellent documentation of the quantity and quality of the irrigation water and a complete knowledge of subsurface flows the fluctuation of EC and water table depth over time has little scientific value.

Haynes & Sons (Kings County)

This is a site that was planted over several years with a variety of trees beginning in January 1986 with the planting of 3194 *Eucalyptus* (species not given). In April that year 250 Poplar trees were planted and on May 1, 1986, 4600 Lake Albacutya *Eucalyptus camaldulensis* were planted. (May 28 replanted 10%) An additional 200 Lake Albacutya *Eucalyptus camaldulensis* and 70 mesquite from UCR were planted on June 9, 1986. July 3, 1986 planted 300 *Casuarina* (species not named) and replanted 288 trees on July 18. In April 1987 14,850 Lake Albacutya *Eucalyptus camaldulensis* were planted bringing the total acreage at that time to 11.3 acres.

Notes: "Lost 33% of January planting, mainly due to frost. Over irrigating south end, but corrected." 10/86 "Rabbits destroyed 95% of Casuarina immediately after planting, installed protectors. Mesquite spacing 10' x10', Poplars just staying alive – grasshopper damage." 3/87 "Rabbits eat all Casuarina without guards some small Euc. Cut down, but not eaten." 5/87 "due to dry year rabbit damage is severe." Fall 87 "East side tends to be drier. Most of E section has fast growth rates, yet entire site is inconsistent growth and survival. Variable growth rates and hi mortality on W, esp. close to alkali vegetation." 12/87 "Field 1 numerous cottonwood seed. 1 tree in field 2 row six is seeding, part of field disked. Field 4 has more sunflower and grass than other fields. Field 5 Bermuda grass is in patches with forbs, dry (wording not clear) ... N. end doing quite well some trees chewed by rabbits."

Additional notes: "Saline sodic soil with Ca+Mg 32 mg/l, trees do well w/ EC 20.2 or 13,184 ppm, take longer w/ 0 Ca+Mg. Irrigation water canal in 1986 EC = 0.04 (25ppm); well EC avg. 1.4 (895ppm). Irrigated once per week Apr. – June 1986 (over irrigation) cut back to twice per month July – Oct. Less irrigation in 1987." No statements are recorded as to quantity of the irrigation water nor was it identified as to quality by pump or canal.

Note from field 1 in March 1987 –"Trees average five ft. 31% died, 69% survived." May 1987 "Field 3 excellent irrigated at two weeks, others fair to good."

Soil samples take 10/1/86

Sample	Depth	PH	EC	Cations	Ca+Mg	Na	SAR	ESP	Notes
	Inches		dS/m	meq/l	meq/l	meq/l			
1	0-8	9.5	9.6	118	1.0	117	165		Dead
2	0-8	8.5	5.0	56	7.1	48.9	26	28	Alive
3	0-8	8.2	52.6	700	67	633	109		Dead *
4/87	0-12	9.0	25.5	340	18	322	107		Dead

* Trees at this location had been planted twice and died both times.

There is considerable data on depth to water table and EC readings of the water at these depths for this site. This data is not presented as a portion of this report as it is basically irrelevant.

A sample of the entire soil profile at well #1 taken 12/86 is as follows:

Sample	Depth	pH	EC	Cations	Ca+Mg	Na	SAR	ESP	Notes
	Inches		dS/m	meq/l	meq/l	meq/l			
1	0-12	8.4	18	230	30.3	200	52	45	Trees
2	12-24	8.5	33	450	60	390	71	68	3'-4'
3	24-36	8.5	32	420	90	330	49	45	Tall
4	36-48	8.6	80	1100	210.5	890	271		Planted
5	48-52	8.4	53	790	140.5	650	78	75	5/6/86

Trees were all doing well and 3 – 4 ft. in height when this sample was taken. This writer wonders if they continued to do well since the profile does not meet the requirements presented in the introduction of this report.

Frank Rodriques (Kings County)

This site was planted in June 1988 and included 19,000 *Eucalyptus camaldulensis* on 31.23 acres. The tree spacing was 6' x 10' on a field that had previously been in wheat. The site location is in Twp 20 Rng 20, Sec. 23, and elevation 240 ft. The soil types are Armona and Vanguard: texture type: loam, texture modifier: sandy loam.

Irrigation water available:

	Pump	Tile sump	Clark Evap. Pond
EC dS/m	1.47	12.4	22.0
Ca + Mg (meq/l)	0	1.70	NT
pH (glass electrode)	8.4	7.9	8.5

Soil samples from four bad spots the owner picked out in the field.

Sample	Depth	pH	EC	Cations	Ca+Mg	Na	SAR	Notes
	Inches		dS/m	meq/l	meq/l	meq/l		
1	0-12	9.8	6.0	72	1.0	71	100	
2	0-12	9.7	15.0	190	1.0	189	267	
3	0-12	9.0	7.2	85	2.0	83	117	
4	0-12	9.6	14.2	178	1.0	177	250	

No other data from this site. Did the trees survive under these conditions?

Stratford Public Utility (Kings County)

At this seven-acre site 11,200 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site in September 1987. Seven tons per acres of gypsum was applied prior to planting. Four days after planting there is a note that all the first days planting were showing toxic stress. By September 30, 1987, twenty days after planting the note states, "ALL TREES DIED!"

The intent of this planting was apparently for irrigation with sewage water. The water analysis of water standing in the border 48 hours after irrigation, high in salinity, may indicate a problem severe enough to cause the immediate death of the trees. EC 12.4 dS/m, SAR 38, pH 8.7.

The soil samples from the table below were taken from the field where the trees were planted. The first eight samples were taken in April 1987 and the others during the period September 10-14 when the trees were planted. In general these EC readings in the upper twelve inches are higher than this species can tolerate. It is not surprising that all the trees died especially with the lack of aeration in the standing water.

Sample	Depth	pH	EC	Cations	Ca+Mg	Na	SAR	Notes
	Inches		dS/m	meq/l	meq/l	meq/l		
NE cor.	0-12	8.3	72.0	1050	257	793	70	
NE cor.	12-24	8.3	32.0	480	80	400	63	
SW cor.	0-12	7.8	36.0	500	253	247	22	
SW cor.	12-24	8.0	30.0	400	178	222	24	
NW cor.	0-12	8.1	28.0	380	94	286	42	
NW cor.	12-24	8.0	18.7	250	65	185	32	
SE cor.	0-12	8.0	27.0	370	143	227	27	
SE cor.	12-24	8.1	37.0	520	196	324	33	
1	0-12	8.0	34	480	185	295	30	
2	0-12	8.2	47	700	140	560	70	
3	0-12	8.3	70	1000	260+	740		
4	0-12	7.9	70	1000	260+	740		

Tulare Lake Drainage District

Beginning May 1, 1987 a mixture of trees were planted at this location. 2000 Lake Albacutya (25 rows) and 100 Mt. Bernstead (2 rows) *Eucalyptus Camaldulensis* were planted together with 200 *Casuarina glauca* (3 rows) and 400 other types of eucalyptus (from Foote)(4 rows). The acreage here was only 3.4. All were spaced in a 5'x 6' pattern. In November the tree growth for six and one half months was measured. By 1992 TLDD was reporting 30 acres (29,000+ trees) of *Eucalyptus* and 5 acres of *Casuarina glauca, C. obesa* and tamarisk. The majority of the *Eucalyptus* trees have been reported as dead as of the summer of 2000. Photos from the air show the *Casuarina* as a thick dark band of trees compared to the thin stands of *Eucalyptus*. Doug Davis, manager of TLDD, states that trees are not an economical option for drainage water reuse and has progressed to using forage. The *Casuarina* is reported as still doing well and they have been irrigated with drainage water every year except one since 1992.

The *Eucalyptus camaldulensis* plantings after the freeze in the winter of 1990 included clones from Lake Albacutya, Lake Coorong, TLDD TP-A, Allan, Gowan, Foote and Gowan, and Menzes. Later, clones 4543, 4544, 4573 and 4590 were also planted.

Water samples were collected at this site on 10/30/91 and 1/6/93. These indicate EC in 5.6-8.4 dS/m range and SAR in 20-24 range. However, the latter sample shows carbonates at 62,700 mg/l. Carbonate concentrations on all samples collected on 1/6/93 were unreasonable when compared to total dissolved solids. The irrigation water was reported as 15,000 ppm TDS and was not applied until after the trees were established for one year. There should be more information available on this project since it was a major project in the early 1990's.

Sachs reports in a letter to Cervinka dated July 3, 1990 that he was awaiting a planting scheme from Gary Rose of TLDD. This was to be set up as a site similar to the demonstration site at Mendota. Cervinka reports that in 1991, 44 acres were planted which were in addition to four acres planted in 1987. Sachs reports that 300 *Eucalyptus camaldulensis* Lake Coorong, and 15-20 each of *Acacia saligna, E. mannifera, E. australiana, E. leucoxylon, E. polybactea, E. polyanthemos and E. longiflora* were delivered to this and other sites.

Oster et al. (1999b) performed a detailed experiment at this site including ripping and gypsum applications. His findings indicate that *Eucalyptus camaldulensis* trees cannot tolerate the combination of high salinity and poor drainage. Lack of aeration in the soil, i.e. low oxygen diffusion rates, was fatal to the trees. This work provided the first field data showing conclusively that lack of aeration in the rootzone is a dominant factor in the survival of eucalyptus trees when irrigated with saline drainage water. It also indicated that the effects of gypsum on aeration and tree growth were large.

Westlake Farms (Kings County)

This site has trees planted and Oster reports that these may be doing better than other trees planted elsewhere in the valley. Information available indicates that 38 acres were planted starting in 1988. A map sketch dated 10/90 shows Lake Albacutya *Eucalyptus camaldulensis* were planted, but makes no mention of any other tree species. Some trees were described as 12 to 18 ft in height. Other portions have notes like "sparse," "scrubby" and "yellow scrubby".

The map relates to the following set of soil data:

Location	Depth	EC	Cations	Ca + Mg	Na	SAR	Notes
	feet	dS/m	meq/l	meq/l	meq/l		
NW ¼	0-1	19.3	249	66	183	31.8	Dry/sparse, better than south
NW ¼	1-2	19.2	248	61	187	33.8	
NW ¼	2-3	19.3	251	70	181	30.5	
SW ¼	0-1	19.2	250	61	189	34.2	Scrubby
SW ¼	1-2	15.4	195	35	160	38.2	
SW ¼	2-3	12.8	160	8	152	76	
SE ¼	0-1	19.2	250	68	182	31.5	*E. camaldulensis* height 18 ft.
SE ¼	1-2	21.4	270	65	205	35.9	
SE ¼	2-3	21.0	280	74	206	33.9	
E. Middle	0-1	19.2	250	65	185	32.4	*E. camaldulensis* height 12 ft.
E. Middle	1-2	15.1	190	34	156	37.9	
E. Middle	2-3	12.8	160	9	151	71.2	
N. Central	0-1	25	325	86	239	13.1	Height 16 ft. Green & seeding.
N. Central	1-2	27	360	80	280	44.3	
N. Central	2-3	12.8	160	6	154	89	
NE ¼	0-1	15.7	198	57	141	26.4	*E. camaldulensis* height 15 ft.
NE ¼	1-2	19.2	248	57	191	35.7	
NE ¼	2-3	14.4	184	22	162	48.7	
S. Middle	0-1	19.2	250	59	191	35.1	Yellow scrubby / second planting
S. Middle	1-2	14.7	185	44	141	30	
S. Middle	2-3	12.8	160	6	154	89	

There does not appear to be any relationship between soil condition and tree growth in this data. Water samples were analyzed 10/30/91, 4/9/92 and 1/6/93. Data from these is provided below:

Date	pH	EC	SAR	HCO_3	NO_3	Cl	SO_4	Na	Ca+Mg	B	Se
		dS/m	adj	meq/l	mg/l	meq/l	meq/l	meq/l	meq/l	mg/l	PPB
10/31/91	8.1	41.5	67	590	230	8140	14,900	10,800	300	22	0.015
4/9/92	7.4	49.8	55.6	291	160	8190	34,800	13,100	555	20	ND
1/6/93	8.1	2.8	40	47,500	65.6	4570	10,700	5500	230	21	0.014

The data from the 1/6/93 is presented as provided. It should be obvious that it is full of errors particularly in bicarbonate.

It is assumed that these data are from observation wells in the tree plantation. It is of little value without some correlated information.

Roy Sachs (1989, 1990) reported in letters to Cervinka, "This appears to be a very harsh site, some of the Alice Spring seedlings are growing in areas where most other seedlings have failed." He intended to collect cuttings from these in October 1989. He collected seeds from two *Eucalyptus gomphacephala* (Gomp1 and Gomp2), which was described, as shrub like, but growing vigorously. He stated that the site had a large loss of trees due to desiccation and beetles. He also selected an Israeli seedling *Eucalyptus camaldulensis-trabuti* hybrid for further evaluation. *E. camaldulensis* clones doing best at this site were 11, 341, and 218.

Verdigal (Kings County)

Beginning in June 1986, 8800 Lake Albacutya *Eucalyptus camaldulensis* and 100 *Casuarina cunninghamiana* were planted at this site. Later, in July 500 *Casuarina* (other) were planted and in June 1987 3000 Lake Albacutya *Eucalyptus camaldulensis* were replanted. The total site acreage was 8 as of April 1988.

Notes: 7/86 "Euc from CDF not doing as well as the others, Cas. died two times in one area. Dug down on replants so that the water .1 to 2 ft, around plant. Replant after irrigation, better survival rate." 3/87 "13% death rate, 87% survival. Some trees died back or were damaged by cotton defoliant. Cas. just alive due to Na in the soil." 5/87 "New regrowth looks good, other plantings better due to irrigation." 9/87 "Replanted some euc's (6/87), prob. reason for death – hi SAR due to Na in soil." 10/87 "Trees died in hot spots due to hi soil salinity. Other than hot spots trees seem to be doing well. Pheasants and sparrows are using the site." It should be noted that soil samples taken Oct. 1986 where trees were dying show EC 19.2-32.0 with SAR 120-194. (These extremely high values were reported!) There is a note that eucalyptus were planted three times and died three times at the sample with the highest levels of both EC and SAR. Other sites also report high tree death rates when SAR is extremely high.
Soil EC at time of planting 4.2 to 15.4 dS/m. Gypsum applied some time back.
Irrigation water: Canal water EC = 0.04 dS/m used first. Irrigation pump water EC = 3.2 dS/m and drainage water, 5.0 to 7.0 dS/m. In 1986 there were six irrigations after planting; drainage water was not used until mixing it with well water on 8/4 and 8/18, the last two irrigations in the first season. Confusing note 3/87 (8 irrigations) 5/87 once this year, then irrigated on 8/12/87.

Water samples were collected from this site in 1987 – 1989. This data is presented in the table below:

Date	pH	EC dS/m	SAR	* CO3- meq/l	No3-N mg/l	Cl meq/l	Na meq/l	Ca + meq/l	Mg meq/l	B mg/l	Se PPB
5/4/87	7.6	6.56	68.8	22.8	4.6	10.8		7.2	8.1	1.3	ND
10/13/87	7.6	7.9	40.4	29.2	1.8	13	96	11.3		2.8	ND
4/25/88	8.1	7.7	44.7	25.9	0.6	11.5	91	8.3		3	ND
1/4/89	7.6	19.8	26.8	10.9	0.4	3.4	25.7	14		1.3	ND
7/18/89	7.7	2.61	68.8	8.9	0.2	6.9	49.6	4.8		1.2	ND
11/1/89	6.8	2.21	50.5	238	47	73	20.4	2.8	1.6	0.9	ND
11/1/89	7	2.33	57.4	397	16	81	22.3	2.7	1.9	1.1	ND

* total carbonate ion in solution (dissolved CO_2 , HCO_3^-, CO_3^{2-})

Table 2: Agroforestry sites which served as test blocks for clone development.

Site Name	Size Acres	Total Trees	Saline Irrig.	EC dS/m	Euc.	Cas.	Soil	GW	Ht. M	DBH cm	Leaf	Notes
Meyers	28.0	38,000	No									Test blk
Lemoore NAS	15+				Yes			Yes				Test blk
Tulare Lake DD *	35.0	29,000	Yes	8.0	Yes	Yes	Yes	Yes	161			Test blk
Westlake Farms	38.0		Yes	17.0	Yes		Yes	Yes			Yes	Test blk
Carvalho	10.0											Test blk
Silviera	5.0	1,500										Test blk
Diener	3.0											Test blk
Barret	5											Test blk
Totals	139.0											

- also appeared in Table 1

Marvin Meyers (Kings County)

At this site, 28 acres were planted starting 8/20/87 with 38,000 trees including 400 Mondel pine. Planted for erosion control –west of I-5. (info in Thompsen file). Sachs in July 1990 reported: "Clones 52 & 53 from Peck Ranch and trabuti were thriving. Not many other clones were that good – in some areas kill was total, but we can't be certain of the cause of death and poor growth. We must learn more about the site – EC of irrigation water, drainage (remember the wet spot where nothing was growing), irrigation frequency."

Lemoore NAS (Kings County)

Trees were planted at this site, but the only data found for the trees were notes by Roy Sachs, who reported that trees did well despite dense weed growth. The best trees were *Eucalyptus camaldulensis* clones 218, 11, 16 and 203 – but these trees were not salinized. The plantation was started in 1988 with one acre; in 1991 15 additional acres were planted. (No data on tree species etc.) On 10/31/91 and 4/9/92, water samples were taken at the site. The 1991 sample shows EC = 7.5 dS/m and SAR 46 which may indicate a marginal site for trees, however the 1992 sample has EC = 7.3 dS/m and SAR 12.7, indicating more satisfactory conditions. There are also some soil and leaf samples available for this period.

Bloemhof (Kern County)

Trees were first planted at this site on June 26, 1986 and include 26,000 *Eucalyptus camaldulensis* (Naperby). Later on July 3, 86, 5500 Mt. Bernstead E. camaldulensis and 1000 *Casuarina* (other) were planted, bringing the total to 31,500 trees on 18.7 acres.

Notes: 6/86 "planted trees in the bottom of furrows so they would get water. Weather hot and dry – high mortality." 7/86 "replants look good, replants on west side of the field." 10/86 "plantings hit hard by hi Na in soil, rabbit damage, prefer Cas. tree

guards installed. Survival 10-20%." 6/87 "planting appears to be very marginal, would recommend that more water be applied, grower not available for comment." (Some areas with no trees, but lush weed growth. Maybe we should be selecting the weeds in this area.)

Irrigation water is EC 0.6 dS/m. Quantities not provided.

Analysis of groundwater below the trees is provided below:

	10/28/86	EC		1/15/87	EC		6/87	EC	
Well #	Depth	dS/m	SAR	Depth	dS/m	SAR	Depth	dS/m	SAR
1	7.6 ft.	88	210	Dry	29?	97?	5.3 ft.	45	179
2	7.6	63	159	8.8 ft.	5.6	18	5.8	62	221
3	8.7	27	87	8.6	41	177	6.2	32	126
4	7.2	47	123	8.6	50	156	6.8	69	224
5	8.1	88	219	8.7	0	-	6.3	26	111
6	8.0	30	77	8.9	47	169	5.1	68	212
7	7.9	71	23	8.4	54	188	5.3	7	27

? There is also a note on well 5 that it was dry on the day of sample collection. If the well was dry – how was a sample obtained. Would there be a mix-up in the samples, because #5 has no EC reading and #1 does?

Soils samples taken on 9/17/87 are provided in the table below:

Sample	Depth	EC	Ca +Mg	Na	SAR	Total salt	Notes
	Inches	dS/m	meq/l	meq/l		meq/l	
1	3-8	37	45	465	98	510	Saline –sodic
2	3-8	5.8	46	22	4.6	68	Saline
3	3-8	28	35	255	61	380	Saline –sodic
4	3-8	24.5	34	299	73	333	Saline –sodic

Way Farms (Kern County)

On May 9, 1986, 11,900 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site. Earlier on April 23 600 poplar trees had been planted. The total acreage planted to trees was 11.5 acres. In October it was reported that this planting was doing exceptionally well with average heights of 5'-6'; trees were smallest in areas with highest salinity. Oregon poplar 6' high and look strong. January 1987 report – "North end has experienced leaf damage due to overspray of cotton defoliant. Several trees in the north end have brown leaves that could be a combination of frost and defoliant." In March 1987 it was reported that the lower 1/3 of field had standing water. Note 6/87 "Appear to have recovered from cotton defoliant damage. Healthier than in Jan. variation in growth still noticeable, NE portion of field remains marginal in tree production and size. Plagued with weeds." Report June 23, 89 – "Rick Wegis said trees were irrigated only 1 ½ years after planting. They have been using groundwater since taking up water from drain ditch to the west. Weeds not as bad as previous summer"

EC soil readings at this site were predominantly below 10 dS/m, but one 3"-6" sample taken 10/28/86 had an EC_e reading of 15.6 dS/m with total salts 200 meq/l, Ca+Mg 36 meq/l and SAR 39. This may indicate the soil conditions in the more marginal area.

Water analysis data (assumed to be from observation wells, but could be drainage water.)

Date	pH	EC dS/m	SAR adj	* CO3- meq/l	No3-N mg/l	+ Cl meq/l	Na meq/l	Ca + meq/l	Mg meq/l	B mg/l	Se PPB
5/7/87	7.3	2.57	25.8	9.5	0.3	10		5.7	2.2	1.5	ND
12/3/87	7.8	3.6	43.6	9.9	7.1	17.6	34.5	7.4		2	ND
5/26/88	7.8	6.8	30.4	18.8	2.2	3	73	11.5		3.5	ND
6/23/89	6.9	7.35	102.1	13.1	0.2	29.7	77.8	6.5		4	ND
				mg/l	mg/l	mg/l					
02/08/91	7.6	8.17	16.5	665	1.1	1624	70	8.9	5.1	2.9	ND
02/08/91	7.8	11.8	62.7	640	4.5	2588	108	10.9	6.1	4.5	ND
5/9/91	8.5	9.12	188	2201	0.2	1453	105.8	11.6	3.5	4.8	ND
5/9/91	8.9	5.9	213.1	1519	10.4	858	67	2.8	0.7	3.9	2.4
12/16/91	7.8	9.3	31.8		25	1700	91.3				2.0

Sulfate was 1100 meq/L in the 5/7/87 sample. It was the only sulfate analysis in this group.

* total carbonate ion in solution(dissolved CO_2 , HCO_3^-, CO_3^{2-}); + wide variation in chloride data may be differece between laboratories- note the change in units

Williams (Kern County)

On May 13, 1986, 7500 Lake Albacutya *Eucalyptus camaldulensis* and 7500 Alice Springs *E. camaldulensis* were planted at this site totaling 13 acres. Then in June 80 mesquite from UCR were added and on July 8, 1986 1000 *Casuarina* (other) were hand planted immediately followed by irrigation water. It was reported in June 86 that the eucalyptus were doing poorly with a 50% loss. "When the soil dries it forms cracks and some roots were torn apart, frequent irrigation to keep the ground moist." This is followed by a note 3/87 " high mortality, probably due to high Na in the soil, 100 (degrees?) F+ during planting, mortality now stabilized."

One soil sample from 6/23/86 indicates soil EC 0-6" 8.4 and 12" 44 dS/m. Other samples taken Nov. 86 from 3"-8" layer indicate respective EC's 14.6, 24, 15.4, and 7.6. In January 1987 the trees were 6-6.5 ft. in height.

These trees were irrigated with water EC 0.3, three times using 24 hour sets, in 1987 as of Sept. The last irrigation that year was reported as June 4.

Buttonwillow Land and Cattle Company (Kern County)

In May 1986 5144 Lake Albacutya *Eucalyptus camaldulensis* were planted on this 4.5 acre site. The trees were hand watered with one quart of water per tree. By the end of the month it was apparent that the upper one third of the field had soil conditions, which were fatal to the trees. The soil conditions reported at the time of planting were upper third cloddy and rough, last ¾? good. Note 1/87 "initial die off stabilized, hi EC and SAR in mortality area (1/3 of area)." 6/87 "Status has remained the same since last report."

The irrigation water, sampled 5/26/88 at this site has EC 0.75 and SAR 15. Boron is 0.5 mg/l.
Soil sample information presented in the table below.

Sample	pH	EC	Total Salts	Ca +Mg	Na	SAR	Notes
		dS/m	meq/l	meq/l	meq/l		
S-1	8.5	45	640	34.4	606	146	Very strongly saline & sodic
S-2		25	350	33.2	317	77	Very strongly saline & sodic
S-3		8.7	100	36	64	15	Mod. Saline –slightly sodic
S-4		6.9					Slightly saline

One would assume from the other comments that the first two samples are from the upper end of the field in which the trees were planted.

Note in file: "Larry Frey decided not to participate in the agroforestry program after 1987 citing economic concerns." It is assumed that Larry Frey is the owner/manager of Buttonwillow Land and Cattle Company.

David Tonigianni (Kern County)

Eucalyptus camaldulensis trees were planted at this site on May 16-17, 1991. This was followed by pepper trees planted in field #3 on June 27. This landowner is reported to have production losses on 65-100 acres. Seven acres, on a portion of three fields, of this land was selected for agroforestry. Trees were also planted along sections of the Kern River flood channel at this time. They irrigated each of the first two weeks after planting then not irrigated again until after five weeks. Thereafter the trees were irrigated only when crop and time constraints allowed. Trees were irrigated with 0.6 dS/m water

Field	Depth	EC	EC
	Feet	dS/m	dS/m
#3 (NE) (NW)	0-1	18.8	9.4
	1-1 1/2	11.7	7.4
	3-3 ½	9.7	8.8
#5A (N) (S)	0-1	6.4	5.2
	1-2	6.7	6.1
	2-3	8.9	5.0
#6A (N) (S)	0-1	24.2	14.0
	1-2	13.4	13.4
	2-3	12.2	9.9

A field visit Oct. 1, 1991 produced the following report:

Field 3 –

The Gowan average 2-4 feet in height and most are showing signs of chlorosis. The Allen[1] appear to be ½ to 2/3 the size of the Gowan. In some places half of the Allen are dead. Only 7 of 58 California pepper trees have survived. They are a foot or less in height.

Field 5A

Approximately 75% of the Menezes average 3-4 feet in height, of the remaining some are two feet and a few have hit the five foot mark. The survival rate is high 80-90%. Some chlorosis is visible; however, it is not as evident as in field 3. The shorter trees show more chlorosis than the taller trees.

Field 6A

The Allen average 2 ½ to 3 feet in height while the Menezes are a little shorter in this field than in field 5A. The Menezes are showing some signs of chlorosis. More Menezes have died in the northern 1/3 of the field while the Allen is shorter in the northern half of the field than in the south. The northern end has higher sodium than the southern end.

[1] In some instances this clone is listed as Alan, Allan and at other times Allen. It is assumed that it was a clone selected from the Dink Allen tree plantation; some of the successful clones such as 4543, 4544 and 4573 were called Allan clones.

Carrollo Site (Kings County)

Carrollo (Carrillo) site in Hanford, Kings County, California provides some insight into the use of trees in sites where the soils may be unsuitable. In this case 18,410 trees were planted on 10.2 acres between April 1 and July 20, 1986. The tree species planted were 17,710 *Eucalyptus camaldulensis* (both Lake Albacutya and Mt. Bernstead clones), 100 *Eucalyptus* (other)[2], 600 *Casuarina* (other)[3], and 100 *Pinus eldarica.* The trees were irrigated nine times in 1986 using canal water with EC = 0.04 dS/m water (25 ppm). The groundwater below the trees fluctuating in depths dependent upon a nearby canal is also non-saline with the highest values being just over 1 dS/m. Observations of the trees were apparently made throughout the 1986-growing season. The records indicate that on October 6, 1986 that trees in some areas had died while others were doing well. It was noted that the better trees were 6-7 ft tall while the poorly performing trees were only 7-12 inches tall. Both *Eucalyptus* and *Casuarina* species were affected in the same manner, which seemed dependent upon the location in the field.

What was the factor causing this difference? Prior to planting, in February 1986, soil samples were collected at four locations, which are provided in the table below.

Sample	Depth	EC dS/m	Cations meq/l	Ca+Mg meq/l	Na meq/l	SAR	ESP
S-2	0-12"	4.7	53	3.0	50	41	38
S	3-18"	3.2	35	4.0	31	22	23
S-3A	6-24"	6.8	80	10	70	31	31
S-3B	24-36"	2.8	30	4.0	26	18	20
Water 1	5 ft.	0.53	5.3	4.0	1.3		

Cations, Ca+Mg and Na are measured in meq/l. Na concentrations were determined by subtraction. The water is assumed to be shallow groundwater.

On March 31, 1986 soils was sampled at one location with more careful consideration being given to collection of samples at various depth separately. The soil is listed as a silt loam and the results of the test are provided in the table below.

Sample	Depth	EC dS/m	Cations meq/l	Ca+Mg meq/l	Na meq/l	SAR	ESP
	0-10"	4.6	52	2.0	50	50	52
	10-20"	2.1	22	2.0	20	20	21
	20-30"	0.59	5.9	2.0	3.9		
	30-40"	0.76	7.6	4.0	3.6	5.0	5.2
	40-50"	0.51	5.1	2.0	3.1	4.7	5.0

[2] When the *Eucalyptus* species is given as "other" it may be any one of the following species: *E. rudis, E. robusta, E. occidentalis, E. grandis, E. viminalis, E. tereticornis* and possibly others as well.
[3] When the *Casuarina* species is listed as "other" it may be either *C. obesa* or *C. equisetifolia.*

On May 12, 1986 water samples were collected at three observation wells. Depths were recorded for all as 4.1 feet and the EC readings were: 1.42, 0.52 and 0.51 dS/m respectively. It was also noted that water stayed on the surface for three days after irrigation. Additional planting or replanting was done on May1, May 27 and June 2, 1986.

In July the trees in some areas had apparently died once again; soil samples were collected in these areas.

Sample	Depth	EC dS/m	Cations meq/l	Ca+Mg meq/l	Na meq/l	SAR	ESP
*	0-12"	3.5	38	1.0	37	52	53
-pH 8.6	0-12"	7.5	85	2.0	83	83	84
-pH 8.4	0-12"	2.54	27	2.0	25	25	26
-pH 9.2	0-6"	9.6	118	1.0	117	167	
-pH 9.5	6-12"	9.3	113	1.0	112	160	

It has become apparent that the soils are sodic and that the irrigation water with such high quality is making matters worse by destroying the physical properties of the soil. Gypsum (phosphogypsum) was apparently applied after the July soil samples. In a report dated 12/86 it is stated, " In two rows gypsum was placed around each tree, it took 2 weeks for the yellowing to disappear from the leaves. 2 months after the application of gyp the two treated rows outgrew the others."

In October soil samples were collected from the same area as the July samples so before and after gypsum treatment information is available.

July sample	Depth	- pH	EC dS/m	Cations meq/l	Ca+Mg meq/l	Na meq/l	SAR	ESP	Notes
-pH 8.6	0-12"	9.0	6.7	80	6.0	74	43	45	Trees died 2X
-pH 8.4	0-12"	9.1	1.56	15.6	3.0	12.6	10	12	Tree grew 4'to7'
None	0-12"	8.9	2.1	22	22	0	0	0	Tree 3' tall
None	12-24"	8.0	3.8	43	3.0	40	32	33	Ditto
None	0-12"	9.3	8.6	105	1.0	104	147		Trees died 2X

A note dated May 1987 indicates that 20 tons of gypsum was applied to eucalyptus only with the statement, "In sodic problem areas, trees are responding to gypsum treatment." The map shows additional trees were planted on June 2, 1987 and that 100 "elderica" pines were planted on June 17, 1987. An additional note that 700 *Eucalyptus camaldulensis* were replanted on the southern portion of the property in July 1987. In one file the last information provided is water depths and EC information from the observation wells dated August 12, 1987. However Dellavalle Laboratory reported June 17, 1988 on a water sample, a soil sample and a leaf sample submitted to them in April 1988. These latter results indicate good quality water with low boron (0.1 mg/l)

and selenium (not detected). The soil sample appears comparable to the better samples provided above EC_e 4.0 dS/m, ESP 31. Boron is given as 1.4 mg/l and selenium was apparently not detected. The leaf sample contains 40 ppm boron and 41 ppm selenium indicating some ability to concentrate these substances from the soil. No information is provided as to the location or purpose of these samples, thus they are not useful for making any additional conclusions.

This case study provides an example of an interesting location where useful information on the growth of trees in sodic soils could have been better documented with additional sample work and analysis of the growth and development of the trees over time. Instead, we find a year of very intriguing summations with a few supporting samples, but no followup in subsequent years; at least no data from such follow-up. Had saline drainage water been available at this site and been used to irrigate the trees there may have been better results from the beginning and an entirely different set of conclusions drawn from the data.

Data from water samples:

Date	pH	EC dS/m	SAR adj	* CO3- meq/l	No3-N mg/l	Cl meq/l	Na meq/l	Ca + meq/l	Mg meq/l	B mg/l
5/4/87	7.5	0.52	2.2	4.9	0.8	0.2	1.5	2.1	2.2	0.2
10/13/87	7.9	0.36	1.2	4	ND	0.2	0.8	4		0.1
4/25/88	7.7	0.42	0.5	6	ND	ND	0.7	4.8		ND
7/18/89		2.55	0.9			59.2	2	9.4		0.4
1/23/91		0.76	7.1	5.9	1.1	39	2.8	3.9	1.3	0.5

* total carbonate ion in solution

Most of the data in the Corrolo report is based upon notes by Frank Menzes.

Kings Boys Ranch (Kings County)

On June 17, 1986, 2200 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site on 1.93 acres. The comments following the planting, though brief suggest an unsuccessful project. "Hard time establishing; Euc. Lost 50%" In July 1986 they may have replanted with Mt. Benstead *Eucalyptus camaldulensis.* Then in March 1987 the following: "Soils hi in Na, low in Ca+Mg, water standing in furrows since Oct. 1" They placed pit run gypsum around each tree. The average growth at this time was 2.2 ft with the Mt. Benstead apparently outgrowing the Lake Albacutya.

Soil sampling prior to the replant in July 1986 is as follows.

Sample	pH	EC dS/m	Cations meq/l	Ca+Mg meq/l	Na meq/l	SAR
Alive	9.2	8.4	100	2.0	98	98
Dead	10.7	18.6	240	1	239	341

Irrigation water from the canal was EC 0.1, and from the pump EC 1.7, pH 9.5, Ca+Mg 1.0, Na 16, N 0.15 (no units given). Well EC is also given as 1.27. There were apparently eleven irrigations in 1986, but no quantities are provided.

Table 3: Agroforestry sites where trees were planted to intercept subsurface water.

Site Name	Size Acres	Total Trees	Saline Irrig.	EC dS/m	Euc.	Cas.	Soil	GW	Ht. m	DBH cm	Leaf	Notes
Robertson		12	No									Intercept
Edwards		20	No									Intercept
Pryse		492	No									Intercept
Martin		492	No									Intercept
Rio Vista		450	No		Yes	No						Intercept
Jones	1											Intercept
Panoche Gin	1	1,641										Intercept
Mendota Sewer Farm		1,505										Intercept
Buena Vista WD	35											Intercept
San Luis Water D	4.5	4367										Intercept

Miscellaneous sites:

1. Orton site (Kings County) 6000 *Eucalyptus camaldulensis* were planted July 1987 on four acres. No other data.

2. Riley site (Kings County) 6000 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site on five acres. Soil data from April 1988. No other data.

3. Rio Vista Farm (Kings County) 450 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site on five acres in August 1987. (Two rows 2600 ft. long) No other data.

4. Rowan (Kings County) 3671 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site on two acres in September 1987. There is detailed spacing and number of rows, trees per row data, but nothing else.

5. Stanton (Kings County) 3000 Lake Albacutya *Eucalyptus camaldulensis* were planted at this site of two acres in July 1987. No other data.

6. Van Groninger (Kings County) planted 70 Lake Albacutya *Eucalyptus camaldulensis* in July 1987. No other information.

7. Gowans Farm (Fresno County) Trees planted starting in 1986 along the aqueduct, near Jeffrey Ave. 1060 *E. camaldulensis* and 528 *Casuarina.* Water table at 24", EC 2-3 dS/m range prior to planting. Irrigated with good water in 1986, no data after July 87. Note: "aqueduct keeps water table high". Sachs reported in 1990, "Tagged two eucalyptus trees, one in border area where soil salinity seems quite toxic (even inhibiting *Casuarina*) and the other vigorous tree where most trees are growing vigorously." Would like to collect seeds and/or cuttings from both trees.

8. Claussen () Ten acres planted to trees in 1989.

9. Danny Newton (Newton Brothers)(Kings County) started planting in 1989, by 1990 had fifteen acres planted. Sachs reported mixed results in July 1990. Trees did best in sandy soil. Newton planned to irrigate with wastewater from Lemoore NAS.

10. Carvallo (Carvalho) (Fresno County) *Eucalyptus camaldulensis* Lake Coorong and other eucalyptus planted on ten acres of trees planted in May/June 1989. On May 24, 89 *Casuarina (?)* from ten provenances in Australia were planted. Gypsum applied liberally in and around planting holes. Irrigation was present within an hour of planting. Trees looked good – Lake Coorong best. No other information on this site.

11. Silviera site (Fresno County) Five acres planted July 28, 1989 with 1500 eucalyptus clones. Sachs noted in July 1990, " very weedy, but all trees growing vigorously. I think the clones are outperforming the CDF seedlings, but we should do measurements this summer or next. Someone should contact Silviera to see if he plans to weed–last year I think he went down rows with a cultivator." Silviera apparently also is growing forage and irrigating with drainage water.

12. Diener (Fresno County) apparently had a project prior to RRR IFDM consisting of three acres (may be the older trees near the sump at RRR). Two acres planted in 1989 and one additional acre in 1990. In July 1990, Sachs reported, "Trees have doubled in height since last summer, they are irrigated with 3000 ppm water according to John. Clones 11, 24, and 218 are performing best, but there are promising other clones. Trees now have roots into the water table. Clone 21 had 100% death rate in the first year."

The following grouping of people in the Alpaugh area, Fresno County, had trees planted as interceptor windbreaks, and to utilize drainage water once established. The soils in this area were once under Tulare Lake and include the Westcamp, Westhaven, and Houser soil series.

13. Donny Jackson (4-J Ranch) 532 *E. camaldulensis* clone 4543 and 404 *E. camaldulensis,* clone 4580 were planted along the canal as vertical pumps on June 18, 1992.

14. Charles Robertson 12 trees in yard planted 6/19/92.

15. Bob Edwards 20 trees planted in yard, along canal on 6/19/92.

16. Calvin Pryse 266 *E. camaldulensis* (4580) and 228 (4543) were planted along a canal on 6/17/92.

17. Steve Martin 228 *E. camaldulensis* (4543) and 266 (4580) were planted along a canal on 6/17/92.

18. Beverly Roth 1100 *E. camaldulensis* clones 4501 and 4570 were planted along edge of pasture and near horse track on 8/15/92.

Someone named Greenleaf (2 acres) and another named Phipps (0.1 acres) also had trees planted in Tulare County under the agroforestry program in 1991.

Additional site names and acreage in Kings County: Barrett (5), Jones (1), Mansiny (10), Nelson (1) and Postupak (5) planted between 1988 and 1991.

Additional site names and acreage in Fresno County: Airway Farms (1), Bravo Farms (7), Britz Farm, Panoche Farms (2), Panoche Gin (1) and Rabb (10) planted between 1989 and 1991.

In addition to these 35 acres of trees were planted by the Buena Vista Water District in Kern County during 1991 for interception purposes and 4.5 acres were planted by the San Luis Water District in Merced County.
Any information on tree planting subsequent to 1991, other than Red Rock ranch remained unavailable to this writer.